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PARATYPHOID FEVER.

A REPORT OF AN OUTBREAK IN A HOSPITAL AT ROANOKE, VA.

By L. L. LUMSDEN, Surgeon United States Public Health Service; A. W. FREEMAN, Assistant State Health Commissioner of Virginia; and W. B. FOSTER, Health Officer, Roanoke, Va.

The following outbreak is reported because of the rarity of reported outbreaks of paratyphoid fever in America and because this particular outbreak presents certain features of interest to epidemiologists.

The institution involved is a private surgical hospital of about 40 beds located in Roanoke, Va. The buildings, situated in the residential portion of the city, are modern and well built. They are supplied with water from the city supply and provided with modern sewerage connected with the public system.

THE OUTBREAK.

The outbreak comprised 16 cases verified bacteriologically, and two other cases, probably paratyphoid, but not verified. At the time of the outbreak the city of Roanoke was practically free from cases of typhoid fever and no cases of paratyphoid had been reported.

The first probable case was in the person of a colored boy who had been for several days employed as a helper in the hospital kitchen. On January 9 he developed a high fever and was removed to a room outside the hospital. Typhoid was at once suspected and a blood culture was made. The blood culture proved negative and the following day the boy left town, returning to his home in the country. According to the best reports available he was sick only two or three days. Ten days later, on January 19, the resident surgeon of the hospital developed a fever and was confined to bed about seven days. His case was diagnosed as influenza, the fever lasting only one day after the patient took to bed. Blood culture was not made. Widal test was negative to typhoid, but there was suggestive clumping, with paratyphoid B. bacilli.

No further cases developed until February 14, at which time the outbreak proper began, comprising 16 cases and lasting until March 26.

CLINICAL COURSE.

The course of the fever was interesting and could be accurately followed, as all the patients were operative cases and their temperatures and pulse rates were recorded on the clinical charts. There were few or no prodromal symptoms, the fever developed suddenly, reaching its maximum of 104° or 104.5° in two or three days, then shading off to normal in from five days to three weeks. The symptoms were all exceedingly mild, the patients being fairly comfortable throughout. One case had dysenteric symptoms at the beginning of the fever, but in the other 15 cases no abdominal symptoms were noted and hemorrhages were absent. Rose spots were noted in most of the cases.

All the patients recovered promptly without complications. The diagnosis was established by agglutinative reactions and by isolating the specific organism from the blood and excreta of the patients.

INCUBATION PERIOD.

The incubation period was apparently from 5 to 10 days, averaging 8 days. One case developed fever five days after admission. In one case, in which the patient spent only a few hours in the hospital, symptoms developed eight days after exposure.

CHRONOLOGY OF THE OUTBREAK.

The chronology of the cases is shown graphically on the accompanying chart. The cases were scattered through the 40 days of the outbreak, 10 cases occurring in the period from February 22 to March 2.

PERSONS ATTACKED.

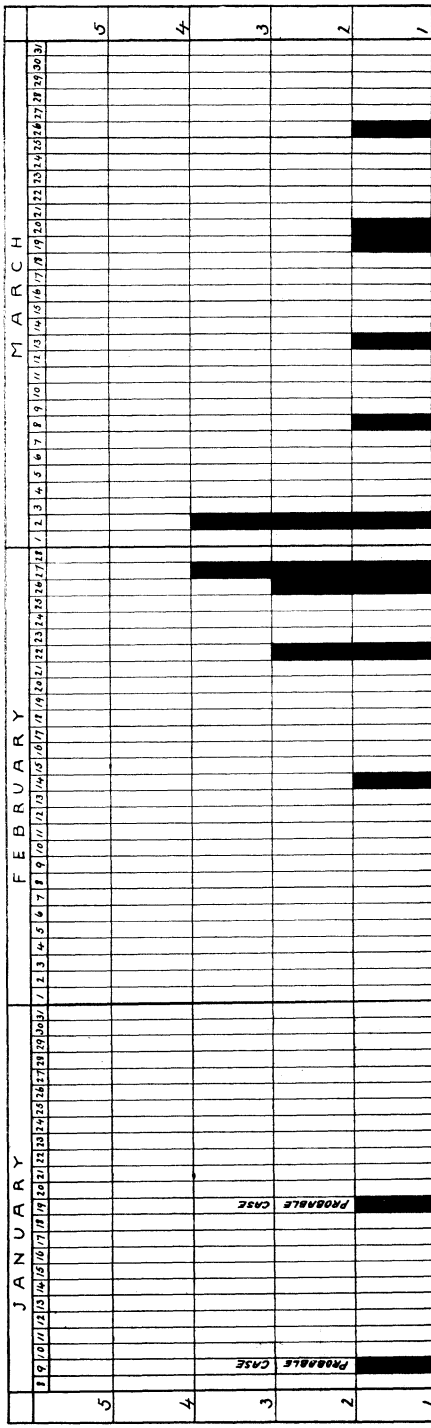
With the exception of the two probable cases previously mentioned, all the cases were among patients of the hospital and none of the staff, nurses, attendants, or help, numbering 35 in all, exhibited any symptoms of the complaint.

Census of the hospital Feb. 25, 1913.

Staff:	
Physicians	5
Nurses	16
Servants	11
Total staff	32
Patients	38
Total hospital population	70

ATTACK RATE.

The attack rate was high. In the period between February 4 and March 26, 84 persons were admitted to the hospital, of whom 16, or 19 per cent, developed the disease.



CASES OF PARA-TYPHOID FEVER ACCORDING TO DATES OF DEFINITE ONSET.

Sex and age of persons attacked.

Sex.	Ages in years.						Total.
	0–4	5–9	10–14	15–19	20–24	25 and over.	
Males	.....	3	1	2	1	.....	7
Females	.....	1	.....	4	1	3	9
Total	.....	4	1	6	2	3	16

LOCATION OF CASES.

The hospital is divided into four wards, two on each floor. The number of patients in each ward averages about 10. Of the 16 cases 12 were in patients in wards 3 and 4, located on the south side of the house, 4 only being in the two wards on the north side of the house. Nine were on the first floor, 7 on the second. The preponderance of cases was, therefore, on the south side of the house, independent of the arrangement as to floors.

FOOD AND DRINK.

The water supply of the hospital is taken from the city supply, which is of excellent quality. The milk is from a city dairy which collects milk from a number of farms and supplies the mixed milk to a considerable proportion of the inhabitants of Roanoke. No cases other than those in the hospital were reported from Roanoke at this time.

All other food supplies are purchased at stores in the city and are common to a large part of the population of the city.

Owing to the fact that the patients were all operative cases, the clinical charts showed exactly what they had received in the way of nourishment and medication from the time of admission to the development of symptoms.

The following table shows the relation of the onset of the fever to the time of admission, of operation, and of the first liquid and solid nourishment:

Case No.	Number days elapsing between—				Case No.	Number days elapsing between—			
	Admission and fever.	Operation and fever.	First liquid food and fever.	First solid food and fever.		Admission and fever.	Operation and fever.	First liquid food and fever.	First solid food and fever.
1	5	5	5	4	9	8	8	6	4
2	8	8	4	1	10	10	9	7	7
3	7	7	5	5	11	10	9	7	7
4	6	6	5	2	12	14	10	7	7
5	9	9	5	4	13	9	9	8	7
6	16	14	12	11	14	10	9	7	5
7	15	6	4	2	15	9	8	8	8
8	11	8	5	4	16	9	9	6	6

CONTACTS.

While in any hospital contact between patients, nurses, and attendants is intimate, in this instance no one person reasonably likely to have been a spreader of the infection could be found who, during the causation period of the outbreak, had been in direct contact with all the persons affected. The division of labor among nurses and attendants is by floors, while the cases were about equally distributed between the floors. There is no division corresponding to the striking preponderance of cases on the south side of the hospital. The internes were assigned by wards. All patients were in contact with the operating staff, but the conditions of surgical asepsis obtaining in the operating room precluded the idea of the infection having been contracted there.

The first case to develop in the course of the outbreak proper was in a surgical patient who, while in the hospital from February 4 to February 28, was accompanied and attended by a relative. This patient was ill with the fever for 6 or 7 days before the nature of the infection was suspected. The relative was an inveterate visitor and in spite of remonstrances did visit and attend in various ways 10 of the 16 surgical patients who subsequently developed the fever. It so happened that most of the old and the newly formed acquaintances of this visitor were among the surgical patients in the two wards on the south side of the hospital, and this fact furnished the only clew found to account for the remarkable preponderance of cases among patients on that side of the hospital.

INSECTS.

The outbreak occurred at a time when flies were almost entirely absent. At the time of the investigation a few flies had appeared, but not in sufficient numbers to justify the conclusion that they had played any considerable part in the spread of the infection.

There was found also one variety of roach, commonly called "Croton bug," which infested every part of the hospital. Other insects were not found.

BACTERIOLOGICAL FINDINGS.

Bacteriological studies were made with a view to determining (1) the nature of the infection from which the patients were suffering, and (2) the source and modes of spread of the infection. Within the period of the investigation 7 of the cases developing in the course of the outbreak were in the hospital and accessible for study. From these 7 patients specimens of blood, feces, urine, wound drainage,

and nasopharyngeal secretions were examined with the results indicated in the following tables:

Patients examined for typhoid and paratyphoid bacilli.

	Date of examination.	Onset of fever.	Blood culture for—			Widal reaction with—		
			Typhoid.	Paratyphoid.		Typhoid.	Paratyphoid.	
				A.	B.		A.	B.
A	Mar. 23	Feb. 26	.....	.....	.....	—	—	—
L	...do....	Mar. 2	.....	.....	.....	—	—	—
H	...do....	Mar. 8	—	—	—[1]	—	—	—
R	...do....	Mar. 13	—	—	+	—	—	—
K	...do....	Mar. 19	—	—	+	—	—	—
S	...do....	Mar. 20	—	—	+	—	—	—
W	Mar. 26	Mar. 26	—	—	+	.....	.....	.....

	Feces culture for—			Urine culture for—			Wound drainage culture for—			Throat culture for—		
	Typhoid.	Paratyphoid.		Typhoid.	Paratyphoid.		Typhoid.	Paratyphoid.		Typhoid.	Paratyphoid.	
		A.	B.		A.	B.		A.	B.		A.	B.
A	—	—	—	—	—	—	.....	.....	.....	—	—	—
L	—	—	—	—	—	—	.....	.....	.....	—	—	—
H	.....	.....	.....	—	—	—	.....	.....	.....	—	—	—
R	—	—	+	—	—	—	—	—	—	—	—	—
K	.....	.....	.....	—	—	—	—	—	—	—	—	—
S	—	—	—	—	—	—	.....	.....	.....	—	—	—
W	—	—	—	—	—	—	.....	.....	.....	.....	.....	.....

[1] Fever declining when blood culture was made.

The technique of making the blood cultures was to take, under aseptic conditions, from a vein at the elbow 5c. c. of blood and plant this in 20 c. c. of sterilized beef bile. After incubating the blood-bile mixture at 37° C. for about 24 hours three drops were plated on Endo's medium. Any typhoid or paratyphoid-like colonies appearing on the plates were planted in bouillon and Russell's medium. After growth had been obtained in these media the cultures were tested with specific agglutinative sera and run through different culture media for positive identification.

The organisms isolated from the blood of patients R, K, S, and W and from the feces of patient R were culturally and morphologically typical paratyphoid B bacilli. They agglutinated promptly in high dilutions of a known specific paratyphoid B agglutinative serum and in dilutions of 1–100 of serum obtained from the patients, but would not agglutinate in relatively low dilutions of either specific typhoid or specific paratyphoid A agglutinative serum.

Blood serum from five of the six patients tested gave a positive Widal reaction with stock paratyphoid B bacilli, but gave negative

results with both typhoid and paratyphoid A bacilli. In making Widal tests dilutions used were 1–50 and time given for reaction was one hour.

The findings from the Widal tests and cultural tests of the blood and feces of the patients left no doubt that the outbreak was caused by the paratyphoid B bacillus.

Since the epidemiological evidence pointed to personal contact as the mode of spread of the infection, the possibility of the infection existing in the secretions of the nasopharynx of the affected persons was considered, but all of the throat cultures were negative. The throat culture was made as follows: A pledget of cotton was rubbed on the tonsils and back wall of the pharynx and then dropped into a tube of bouillon. After the tube had been incubated about six hours, plants were made from its contents onto Endo plates. Paratyphoid-like colonies appearing on the Endo plates were fished and tested on the different determinative culture media and with specific agglutinative sera. The paratyphoid agglutinative sera used were obtained from rabbits at the Hygienic Laboratory in Washington, D. C., which had been injected periodically with increasing doses of cultures of organisms of the paratyphoid A and paratyphoid B groups, respectively.

In the endeavor to determine the sources of the infection examinations were made (1) of collections of dirt and drainage from the refrigerator in the main kitchen; (2) of flies, roaches, and rats caught in the hospital; (3) of samples of the water supply; and (4) of specimens of blood, feces, urine, and nasopharyngeal secretions from all persons—including especially physicians, nurses, and servants—in the hospital to whom the epidemiological evidence pointed as possible carriers of the infection. The results of all these examinations were negative for paratyphoid bacilli.

Including the 14 or 15 persons to whom the epidemiological evidence pointed as possible carriers of the infection, there were in the hospital 29 persons all told whose blood was tested with paratyphoid bacilli for the Widal reaction, and 37 all told whose feces and urine were examined for paratyphoid bacilli, but all with negative results.

The several collections of insects emulsified and examined consisted of flies and roaches caught during the period of the investigation in the wards, kitchens, and dining rooms of the hospital.

Three samples of the water supply—one from a tap on the north side of the hospital, one from a tap on the south side of the hospital, and one from a tap at the laboratory several blocks down town from the hospital—were examined for *Bacillus paratyphosus* and *Bacillus coli*. All three samples were negative for *Bacillus paratyphosus*. Two of the samples in quantities of 1 c. c. and 10 c. c. were negative for *Bacillus coli*, while one, the sample collected from the tap on the

north side of the hospital, showed *Bacillus coli* in the 10 c. c. portion, but not in the 1 c. c. portion.

Summarized, the bacteriological studies established beyond reasonable doubt that the outbreak was caused by infection with *Bacillus paratyphosus*, group B, and suggested by the negative findings in the search for carriers (1) that the outbreak was on the wane, and (2) that the infection was confined to the patients, and therefore readily controllable.

POSSIBLE SOURCES OF INFECTION.

A careful study of the evidence collected and summarized above led to the prompt exclusion of certain factors as possible causative agents. The importation of the infection from outside the hospital in water, milk, or other foods could be positively excluded. The disease was too evidently limited to the hospital to allow of any such assumption.

The possibility of a carrier in the general kitchen infecting the food at the time of its preparation was, of course, thoroughly considered. The absence of infection among the house staff and attendants, the fact that a number of cases had had no food from the general kitchen before developing fever, and the peculiar distribution of cases in the hospital strongly negatived this possibility. Infection of food in the diet kitchens was also highly improbable, since there are only two diet kitchens, one for the two wards on each floor, and the distribution of the cases was uniform between the two floors, but over three times greater for the two wards on the south side than for the two wards on the north side of the hospital.

Besides a very few flies and a good many roaches, no insects were found in the hospital. The flies and roaches appeared to be distributed quite uniformly throughout the hospital. Such insects as these would be expected to operate in the spread of paratyphoid infection through the contamination of foods. The distribution of cases, the evidence against the infection having been distributed from the kitchens, and the negative results of the bacteriological examination of several considerable collections of the insects strongly suggested that insects could not have played more than a very small part, if any, in the dissemination of the infection.

The possibility of a human carrier infecting by finger contact the persons affected was thoroughly considered. No one person except the resident surgeon and the head nurse had been in contact with all the patients. It was not considered in the least likely that either of these two persons had had any considerable part in the spread of the infection, and furthermore the bacteriological examinations of blood, feces, urine, and nasopharyngeal secretion from the entire staff,

nurses, servants, and attendants gave negative results for paratyphoid infection. Thus both the epidemiological evidence and the bacteriological findings were strongly against the possibility of a human carrier among the personnel of the hospital being the source of the infection.

After the reasonably definite exclusion of all the factors usually first to be suspected in institution outbreaks, there remained for consideration personal contact, or conveyance of the infection to the surgical patients by fingers of persons who were attending actual but unrecognized cases of paratyphoid fever. The disease, probably introduced by the colored boy and continued by the house surgeon, existed for several days in the first case to develop in the outbreak proper before the nature of the infection was suspected. It is quite possible that at the time the house surgeon became infected some of the other members of the hospital personnel or some of the surgical patients in the hospital also became infected without subsequently manifesting the disease in a clinically recognizable form. The hospital is a surgical one and its personnel is unaccustomed to treating communicable diseases. The infection, becoming seeded in the wards while the first cases were being regarded as "grippe," may have been transmitted on the fingers of nurses and attendants, through clinical thermometers, drinking glasses, specially prepared diets, etc., from patient to patient. The meddlesome visitor, before referred to, may have had a part in the spread of the infection.

REMEDIAL MEASURES.

The measures recommended to control the infection were as follows:

1. Rigid isolation of all the cases.
2. Prompt and thorough disinfection of excreta from all patients in the hospital, with disinfection of bedpans and urinals each time used.
3. Strict medical asepsis on the part of all nurses in going from patient to patient.
4. Sulphur fumigation of pantries and kitchen to destroy water bugs and other insects.
5. Trapping and "swatting" of flies.
6. General and thorough cleaning of the entire hospital.

All of these measures became effective March 26, 1913. Rigid isolation of all suspected cases had been effected for about a week before. The last case in the outbreak developed on March 26. No further cases have been reported to date, May 17.

CONCLUSIONS.

1. The disease prevailing in the hospital was a fever caused by infection with *Bacillus paratyphosus* B.

2. The incubation period was 5 to 10 days, averaging 8 days.

3. The organism was recoverable by blood culture from cases on the first day of the disease.

4. The infection was spread by finger conveyance from case to case in the wards.

5. Strict medical asepsis was sufficient to control the spread of the disease.

OUTBREAK AND SUPPRESSION OF PLAGUE IN PORTO RICO.

AN ACCOUNT OF THE COURSE OF THE EPIDEMIC AND THE MEASURES EMPLOYED FOR ITS SUPPRESSION BY THE UNITED STATES PUBLIC HEALTH SERVICE.

By RICHARD H. CREEL, Passed Assistant Surgeon, United States Public Health Service

Summary.

There were 55 cases of human plague in the Porto Rico epidemic, 10 having occurred at the date of announcement of the disease and 45 thereafter. All were of the bubonic type, with a mortality of 65 per cent.

Flea infestation in Porto Rico is very low compared with other tropical countries. The data is not sufficient to determine if there is a seasonal variation. The species of fleas encountered on rodents were: *Xenopsylla cheopis, Echidnaphaga gallinacae, Ctenocephalus canis,* and *Pulex irritans,* with the addition of *Rhynchoprion penetrans* on human host. The infectation of rats by chicken flea in San Juan is noteworthy. The decline in rat population, as indicated by the weekly catch, was marked and to a large degree was the result of rat proofing. The rat infection extended to four points outside of San Juan: To Carolina, a distance of 14 miles; Caguas, 23 miles; Arecibo, about 50 miles, and Rio Piedras, 3 miles. Only in the first-named village did human cases occur.

The presumptive evidence points to an extension by infected rats in merchandise. The infection in Rio Piedras might have been carried there by migratory rodents.

In Porto Rico the *Mus norvegicus, Mus alexandrinus* and *Mus rattus* infest houses, but the former predominates. *Mus alexandrinus* is the species found in rural districts. Sufficient data is not at hand as to the variation of breeding, but it is probable that there is no seasonal fluctuation of this nature among the rodents of Porto Rico.